Amendments to the Specification

Please replace the paragraph beginning on page 5, line 23, with the following rewritten paragraph.

There are several additional disadvantages to currently available systems and methods for three-dimensional inspection of bumped wafers. For example, as described above, such systems are configured to scan a wafer more than once in series to acquire 2D and 3D data for inspection and metrology. In addition, ~~configuration~~ configurations of such systems are incompatible with rapid scanning of relatively large areas of bumped wafers. Such disadvantages will generally lower a throughput of an inspection and metrology system. Furthermore, such systems may be relatively complex due to the use of separate 2D and 3D data acquisition and processing systems. This disadvantage will generally increase cost and reduce reliability of an inspection and metrology system.

Please replace the paragraph beginning on page 13, line 4, with the following rewritten paragraph.

As will be further described herein, elements that may be similarly configured in each of the embodiments illustrated in Figs. 1-19 have been indicated by the same reference characters. It is noted that Figs. 1-19 are not drawn to scale. In particular, the scale of some of the elements of the figures ~~are~~ is greatly exaggerated to emphasize characteristics of the elements. It is also noted that Figs. 1-19 are not drawn to the same scale.

Please replace the paragraph beginning on page 14, line 16, with the following rewritten paragraph.

The system may include an imaging system configured to form an image of the structure by scanning specimen 12 with partial oblique illumination 22, as shown in Fig. 1. For example, the imaging system may include illumination system 24 configured to project partial oblique illumination 22 onto specimen 12. Fig. 3 illustrates a partial schematic side view of an

embodiment of illumination system 24. As shown in Fig. 3, illumination system 24 includes light source 26. Light source 26 may be configured to emit broadband light. For example, light source 26 may include, but is not limited to, a white light source. Alternatively, light source 26 may be configured to emit monochromatic or narrow band light. For example, light source 26 may include, but is not limited to, a laser or a light emitting diode (LED) configured to emit light having a single wavelength or a narrow band of wavelengths of light. The single wavelength or narrow band of wavelengths of light may include, for example, blue light, green light, or red light. The wavelength of the light source such as a laser or an LED may vary depending upon, for example, characteristics of structures 10 and/or specimen 12. For example, if the specimen includes a resist layer, an appropriate wavelength of light may include green light. Alternatively, if the specimen includes a material such as copper or gold, an appropriate wavelength of light may include red light. In addition, light source 26 may be configured to emit light other than visible light such as ultraviolet light and infrared light.

Please replace the paragraph beginning on page 17, line 17, with the following rewritten paragraph.

In this manner, the images formed by the sensor will vary depending upon a height of the structures and are a measurement of how much time the structures spend in ~~the~~ illuminated volume 34 of partial oblique illumination ~~34~~ 22. For the case in which the illuminated volume is located above the terminator, the time that structures spend in illuminated areas 34 of partial oblique illumination ~~34~~ 22 may be approximately proportional to a height of the structures. TDI sensor 40 may also be configured to integrate an intensity of the image formed by scanning the specimen with partial oblique illumination ~~34~~ 22. Therefore, the total integrated brightness of images of the structures may be approximately proportional to a height of the structures. Conversely, if the illuminated volume is located below the terminator, the integrated brightness of the images of the structures may be approximately inversely proportional to the heights of the structures. Hereafter, all discussions of this measurement effect apply to both configurations of the illuminated and non-illuminated regions, even if only one may be mentioned as an example.

Please replace the paragraph beginning on page 18, line 1, with the following rewritten paragraph.

As shown in Fig. 5, he specimen is scanned in direction x over a period of time, t. In other embodiments, the specimen may be scanned in other directions such as a y-direction, which is substantially perpendicular to the x-direction, over a period of time, t. The partial oblique illumination may be arranged at an azimuthal angle with respect to the scanning direction. For example, the partial oblique illumination may be arranged at an azimuthal angle of about 0° or about 90° with respect to the scanning direction. Bumps 60 having a height greater than bumps 62 will spend a longer period of time in ~~the~~ illuminated area 34 of the partial oblique illumination[[~~34~~]]. TDI sensor 40 forms an image of bumps 60 and 62 as the images move across the TDI sensor. Therefore, intensity I_B and I_A of the images of bumps 60 and 62, respectively, integrated over time by the TDI sensor will be approximately proportional to the height of the structures.

Please replace the paragraph beginning on page 18, line 23, with the following rewritten paragraph.

Another embodiment of system that includes a different configuration of the measurement TDI is illustrated in Fig. 7. In this embodiment, measurement TDI 40 is operated at a speed greater than a speed of stage 44 on which specimen 12 is supported during imaging thereby causing images formed by the measurement TDI to be smeared. Stage 44 is described in more detail below. The stage may be moved in scan direction 46 such that the knife edge terminator is scanned across specimen 12. The knife edge terminator shadow cuts off structure images as they cross from illuminated area 34 to non-illuminated area 36, in proportion to their height. As shown in Fig. 7, the images produced by measurement TDI 40 of structures 10 on specimen 12 ~~has~~ have smeared length 48 and intensity 50 that ~~is~~ are proportional to ~~its~~ their ~~height~~heights.

Please replace the paragraph beginning on page 21, line 13, with the following rewritten paragraph.

The processor may include an image processing device coupled to the imaging system. An image processing device may be a parallel processing system that may be commonly used by the machine vision industry. The image processing device may be configured to generate an image of an illuminated area of specimen 12. The image processing device may also be coupled to a host computer (not shown) that may be configured to control the system and to perform data processing functions. For example, data processing functions may include, but are not limited to, flagging defective structures by comparing a determined height of the structure to a predetermined range of the height of the structure, automatic defect classification, extracting a structure layout on the specimen from the data acquired from the TDI sensor, providing surface and volume information from the data, providing summary files and defect map files such as an industry standard KLA results format (KLARF) wafer map commercially available from KLA-Tencor, determining if the specimen should be reworked or repaired, and determining if a defect is in a critical ~~and~~ or non-critical portion of a specimen. An example of a method for determining if a defect is in a critical portion of a specimen is illustrated in PCT Application No. WO 00/36525 by Glasser et al., which is incorporated by reference as if fully set forth herein.

Please replace the paragraph beginning on page 22, line 1, with the following rewritten paragraph.

The processor may also be configured to determine and/or alter a parameter of a process tool used to process the specimen using a feedback and/or feedforward control technique. For example, the processor may use feedforward or feedback algorithms to alter a parameter of an instrument coupled to a process tool. The feedforward or feedback algorithms may include algorithms that include variables for, but not limited to, the specific process tool that processed the specimen, the process parameter used to process the specimen, a history of the process tools and/or process steps performed on the specimen, and the maintenance history of the process tool. The algorithms may run in conjunction with advanced process control algorithms that may be included in commercially available software such as Catalyst available from KLA-Tencor. Data

for the above variables may include information collected from process tools throughout a fab and may be organized and stored in a fab database using commercially available software such as PMC-Net also available from KLA-Tencor.

Please replace the paragraph beginning on page 23, line 14, with the following rewritten paragraph.

As shown in Fig. 9, TDI sensor 52 may be coupled to blocking device 72, which may include, for example, a shutter. In this manner, TDI sensor 52 may be blocked, or otherwise controlled, such that only a percentage of the pixels of the TDI sensor are used to generate the reference image. As such, TDI sensor 52 may perform only a percentage of the total integration across the sensor (i.e., about 15 % to about 75 % integration, or about 50 % integration). In this manner, an image formed by TDI sensor 52 may more closely match an image formed by TDI sensor 40 by reducing the differences between illumination used to form the images. Other methods for reducing the reference image exposure may employ a neutral density filter or an attenuating beam splitter. Such a blocking device, blocking method, or another control method, however, may not be used, and differences between the illumination used to form the images may be reduced using, for example, a model or a calibration curve.

Please replace the paragraph beginning on page 25, line 26, with the following rewritten paragraph.

Fig. 11 illustrates a partial schematic cross-sectional view of a different embodiment of a system configured to determine a dimension of a structure on a specimen by projecting two or more knife edge terminators on the specimen. A series of knife edge terminators 86 and matching slits 88 on measurement TDI 40 are arranged so that structures 10 receive an increasing amount of light through a specific height measurement range. In this manner, the measurement TDI sensor may integrate an image of a structure multiple times as it passes across each of the two or more knife edge terminators. Between [[~~a~~]]minimum and maximum height, specimens receive light directly proportional to their heights, across multiple regions. Above this height range, and depending on the relative width and angles of the illuminated region 200

and imaged region 201, a taller structure's image intensity will be inversely proportional to its height or its intensity will remain at constant exposure for a range of heights before becoming inversely proportional to height above that range.

Please replace the paragraph beginning on page 27, line 1, with the following rewritten paragraph.

Fig. 12 illustrates a partial schematic side view of an embodiment of a system configured to determine a dimension of a structure on a specimen having multiple partial oblique illumination channels. For example, the imaging system may include additional illumination system 90. The additional illumination system may be configured to project partial oblique illumination 92 onto specimen 12. Illumination system 24 and additional illumination system 90 may have approximately equal angles of illumination across the field of view. Alternatively, illumination system 24 and additional illumination system 90 may have substantially different angles of illumination across the field of view. In this manner, the two illumination systems may be used to scan ~~specimen~~ <u>specimens</u> having structures with a relatively broad range of heights and/or substantially different types of structures. The additional illumination system, however, may be configured to project partial oblique illumination 92 onto the specimen from a different azimuthal angle than partial oblique illumination 22. The additional illumination system may also be configured to project partial oblique illumination 92 onto the specimen from different azimuthal and/or polar angles than partial oblique illumination 22. For example, as shown in Fig. 12, illumination system 24 and additional illumination system 90 may be configured to project partial oblique illumination 22 and 92, respectively, at substantially opposite azimuthal angles and/or the same or different polar angles. Both of the partial oblique illumination channels, however, may be arranged at any azimuthal angles with respect to each other, any azimuthal angles with respect to the swath, and/or any azimuthal angles with respect to the scanning direction. For example, both of the partial oblique illumination channels may be arranged at an azimuthal angle of about 0° or about 90° with respect to the scanning direction. The additional illumination system may be further configured as described herein.

Please replace the paragraph beginning on page 29, line 15, with the following rewritten paragraph.

Fig. 15 depicts a partial schematic side view of an embodiment of a system configured to perform multi-dimensional metrology and inspection of a specimen. The system may be configured as described herein. In addition, the system includes second imaging system 104 configured to form a bright field image of the specimen by scanning specimen 12 with bright field illumination 106 and detecting the bright field illumination reflected or scattered from the specimen. The second imaging system 104 may also be configured to form a dark field image by detecting partial oblique illumination reflected or scattered from the specimen. Both bright field illumination 106 and oblique illumination 22 may support 2D metrology and inspection of the specimen. For example, second imaging system 104 includes light source 108 configured to project light to the specimen such that the light may be scanned across the specimen. The light source may include any of the light sources as described above. An angle of illumination of second imaging system 104 may be approximately normal to an upper surface of the specimen. In addition, the bright field illumination and partial oblique illumination channels may have different wavelengths, different polarizations, or another different characteristic. In this manner, TDI ~~sensors~~ sensor 40 and sensor 110 of the second imaging system may be configured to detect light from only one of the illumination channels thereby reducing, or even eliminating, effects due to scattering from the multiple channels.

Please replace the paragraph beginning on page 30, line 4, with the following rewritten paragraph.

Sensor 110 for second imaging system 104 may be configured to detect light specularly reflected from the specimen. In such an embodiment, the sensor may be disposed within second imaging system 104. The specularly reflected light may be directed to the sensor by components of the second imaging system. For example, light returned from the specimen may be directed to sensor 110 by beam splitter 112 or another suitable optical component. Alternatively, the sensor of second imaging system 104 may be configured to detect light scattered from the specimen. For example, as shown in Fig. 16, sensor 114 may be arranged at an oblique angle to the

specimen. In this manner, sensor 114 may detect light from the normal illumination channel ~~108~~ that is scattered from the specimen. An appropriate sensor 114 for the second imaging system may include, for example, a TDI sensor, a linear CCD camera, or any other appropriate device known in the art. Another appropriate sensor 114 for the second imaging system may include a pair of TDI sensors, which may be configured as described herein.

Please replace the paragraph beginning on page 34, line 1, with the following rewritten paragraph.

Fig. 19 illustrates an additional embodiment of a system configured to perform multi-dimensional metrology and inspection of a specimen. The system may be configured to determine a dimension of a structure on a specimen using multiple partial oblique illumination ~~channels~~ 22 and 92 as described herein. The system may also include multiple TDI sensors 40 and 93 configured to form an image of specimen 12 from each partial oblique illumination channel as described herein. In addition, the multiple partial oblique illumination channels may have different wavelengths, different polarizations, or another different characteristic. The system may include other components and may be further configured as described herein. In addition, the system may include second imaging system 104 configured to form a bright field image of the specimen by scanning the specimen with bright field illumination 106 for 2D inspection and metrology. Bright field illumination 106 may have a different wavelength, different polarization, or another different characteristic than both partial oblique illumination ~~channels~~ 22 and 92. Such an embodiment may be configured to perform 2D and 3D inspection and metrology substantially simultaneously or simply within the same pass as described herein.

Please replace the paragraph beginning on page 34, line 16, with the following rewritten paragraph.

Each of the embodiments of a system described above may also include a stage, as shown in Fig. 1. The stage may be configured to support the specimen during scanning of the specimen as described above. The stage may also be configured to move the specimen such that the imaging system may scan the specimen. Alternatively, the stage may be configured to remain

stationary while the illumination system and the TDI sensors are moved such that the imaging system may scan the specimen. In addition, a vertical position of the stage may be substantially constant during scanning of the specimen by these systems. For example, after the specimen is brought substantially into focus by altering a vertical position of the stage or the optics of the imaging system prior to performing inspection and/or measurement, the stage may not be moved substantially in a direction indicated by vector 78, as shown in Fig. 1 in order to perform inspection and/or a measurement. As described above, such a system is substantially different than some conventional 2D and 3D inspection and metrology systems that are configured to alter a vertical position of a specimen several times to obtain several confocal images of the structure at various vertical positions.

Please replace the paragraph beginning on page 36, line 11, with the following rewritten paragraph.

In an embodiment, the method may also include scanning the specimen with full oblique illumination to form a reference image of the ~~specimen~~ structure, as shown in step 134. Such a method may also include integrating an intensity of the reference image, as shown in step 136. In an embodiment, the method may include determining a height of the structure from the integrated intensities of the image and the reference image as described herein. In a further embodiment, the method may include reducing, or even eliminating, albedo differences between structures on the specimen using the reference image, as shown in step 138.